

# Stored Thermal Energy

Angie M. Shepherd  
William E. Haskell

National Institute for Occupational Safety and Health  
National Personal Protective Technology Laboratory

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# Project Background

- Protective clothing or turnout gear is designed to insulate a fire fighter from the thermal environment.
- Protective layers and air gaps prevent the energy of the fire environment from being transferred to the fire fighter.
- Burn injuries occur when stored thermal energy (STE) within the garment layers are quickly transferred to the skin through compression of the layers.
- Current standards and testing methods do not adequately evaluate the risk caused by STE.



Photos courtesy of IAFF

# Burn Injury History

- Fire fighters have referred to these burns as stored energy burns, steam burns, and compression burns
  - Little to no visual damage to the outershell material
  - Occurs more frequently in areas of the body covered with dense reinforcement materials



Photos courtesy of NCSU

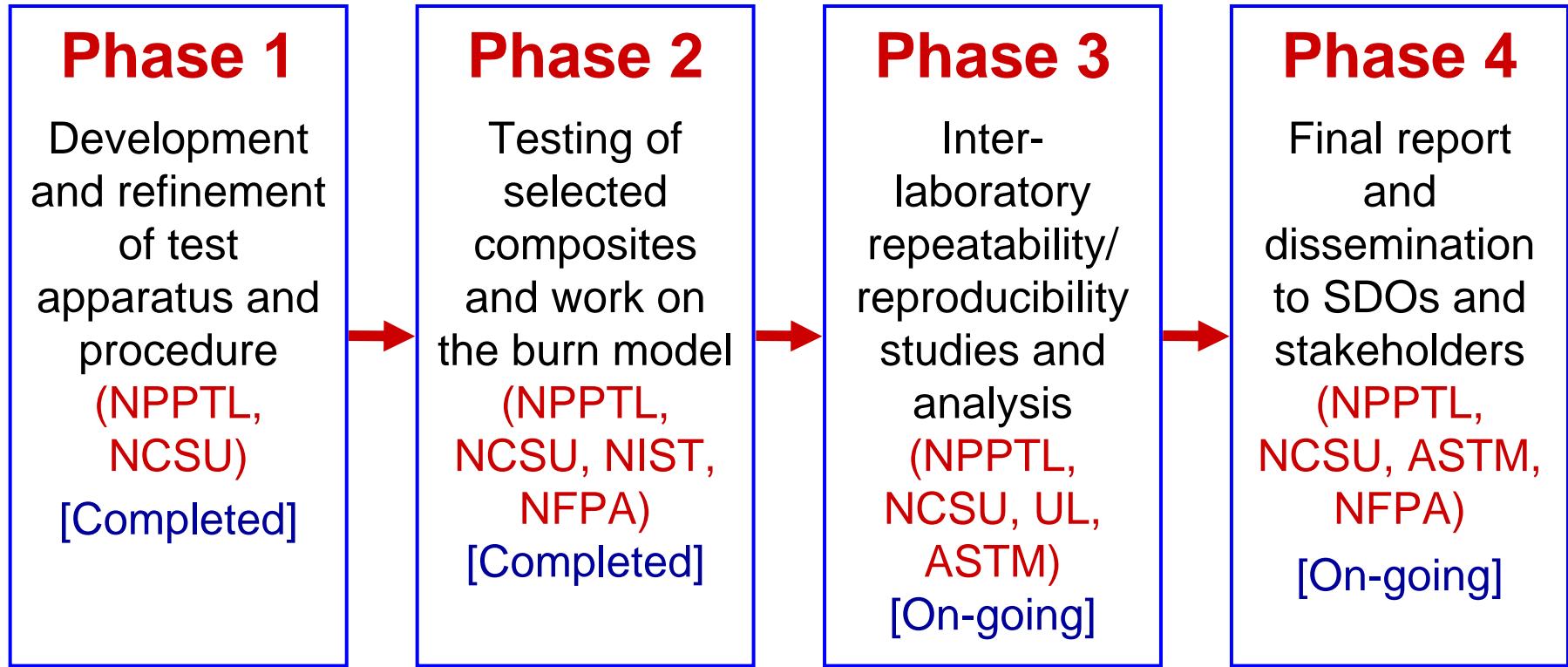
# Project Objectives

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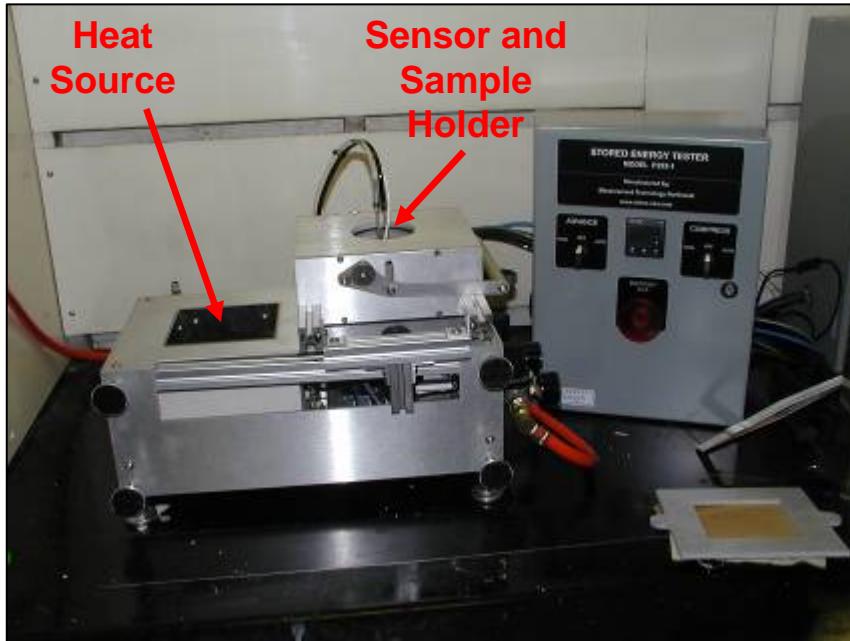


- Development of an apparatus and a procedure to measure the stored thermal energy (STE) in material composites
- Conduct variability studies between test labs using the STE method and apparatus
- Creation of ASTM standard entitled “Standard Test Method for Measuring the Transmitted and Stored Energy of Firefighter Protective Clothing Material Systems”
- Recommend method, parameters, and criteria to the NFPA Technical Committee on Structural and Proximity Fire Fighting

# Project Approach



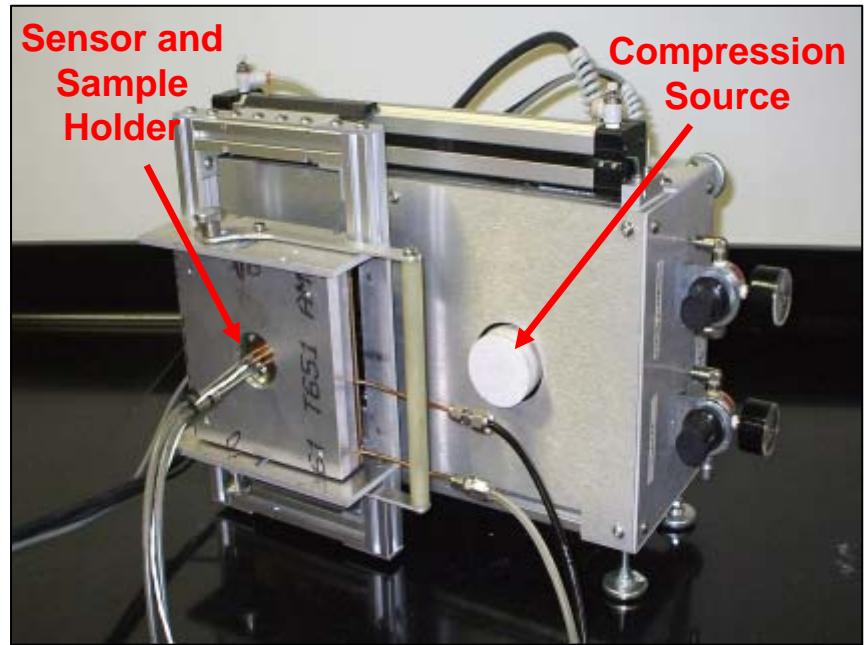
# STE Test Apparatus



Initial Design - Horizontal

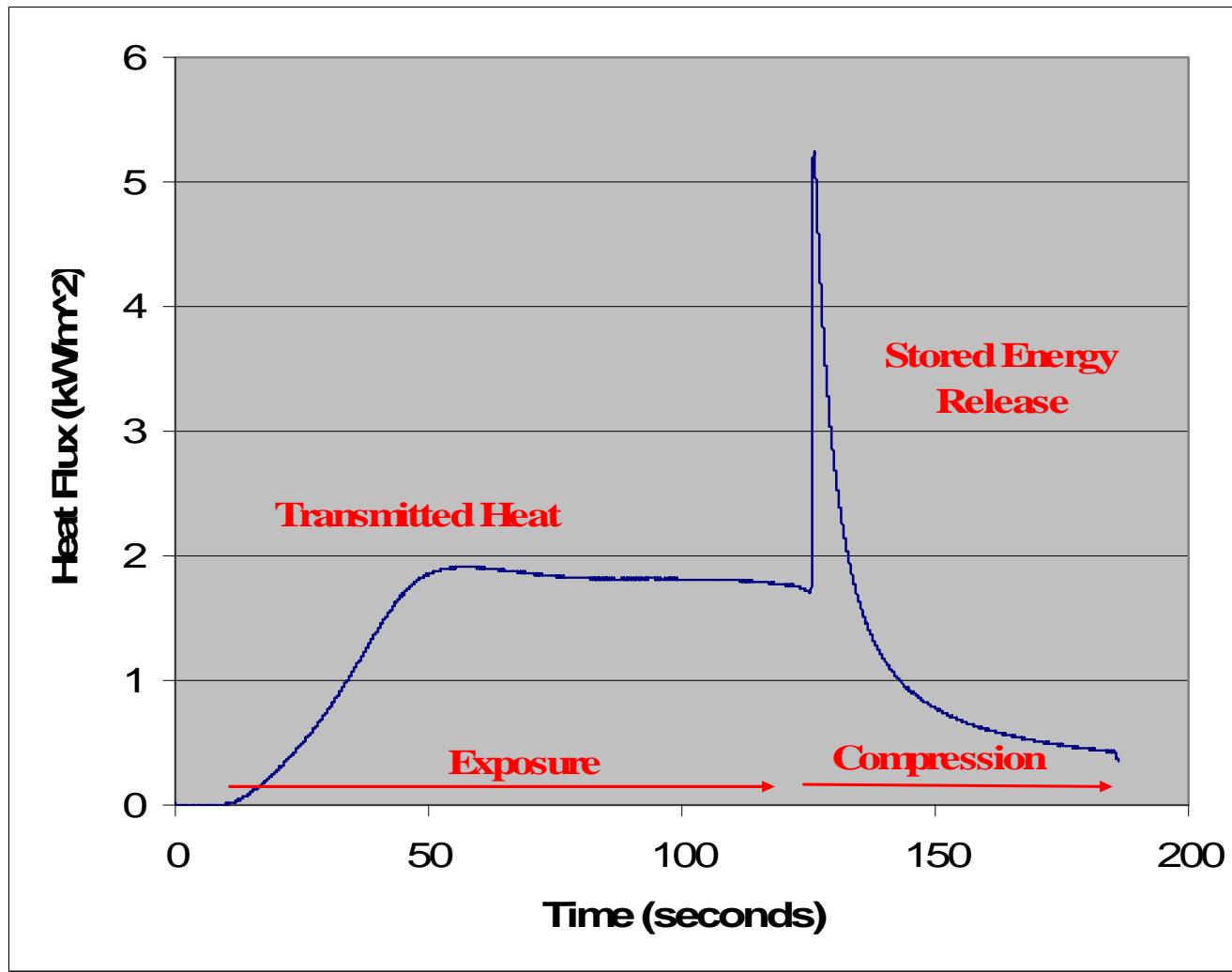


Sample Composite  
with Reinforcement



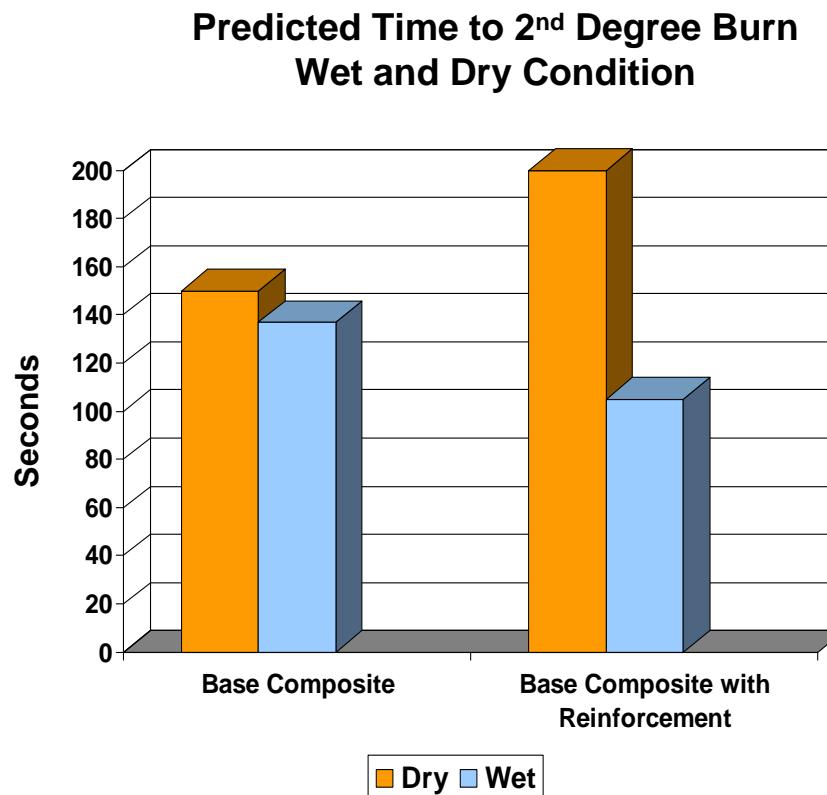
Current Design - Vertical with  
Water Cooled Sensor

# Example STE Results



# Moisture and Material Effects

- No Moisture Preconditioning
  - Similar to other thermal tests (TPP, RPP)
  - Reinforced samples have higher times to 2<sup>nd</sup> degree burn
- With Moisture Preconditioning
  - Time to burn drops with all samples
  - Composites with dense impermeable reinforcements have lower times to 2<sup>nd</sup> degree burn



# Project Outputs

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- ASTM Draft Standard, WK10531 - Measuring the Transmitted and Stored Energy of Firefighter Protective Clothing Systems
- Phase 1 Final Report titled, “Development of a Test Method for Measuring Transmitted Heat and Stored Thermal Energy in Firefighter Turnouts”
- Phase 2 Final Report titled, “Thermal Capacity of Fire Fighter Protective Clothing” - Available on the web:  
[http://nfpaf.org/assets/files/PDF/Research/PPE\\_Thermal\\_Energy.pdf](http://nfpaf.org/assets/files/PDF/Research/PPE_Thermal_Energy.pdf)

# PPT Program Impact

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- PPT Program Objective – Improve emergency responder protective clothing to reduce exposure to thermal, biological and chemical dermal hazards
- Incorporation of the method into nationally recognized standards is expected to reduce the number of burn injuries sustained by fire fighters due to stored thermal energy transfer
- Additional surveillance outside this project is needed to acquire anything more substantial than anecdotal information

# Quality Partnerships Enhance Worker Safety & Health

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## Acknowledgements

North Carolina State University

NFPA Fire Protection Research Foundation

ASTM F23 Committee on Protective Clothing and Equipment

International Association of Fire Fighters

[www.cdc.gov/niosh/npptl/default.html](http://www.cdc.gov/niosh/npptl/default.html)

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